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Expert elicitation as tool for climate and hydrological model uncertainty reduction

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Hans Jørgen Henriksen, Ernesto Pasten-Zapata, Peter Berg, Rafael Pimentel, Guillaume Thirel, Andrea Lira-Loarca, Eva Sebök and Christiana Photiadou

Session:
SSS10.4
Quantifying and communicating uncertain information in earth sciences

Chat time: Wednesday, 6 May 2020, 14:00–15:45

Project AQUACLEW is part of ERA4CS, an ERA-NET initiated by JPI Climate, and funded by FORMAS (SE), DLR (DE), BMWFW (AT), IFD (DK), MINECO (ES), ANR (FR) with co-funding by the European Union (Grant 690462).

Highlights

- *An **Expert Evaluation (EE workshop) procedure for uncertainty reduction*** has been developed in AQUACLEW (JPI-Climate).
- The elicitation can be compared to ***quantitative approaches***
- Can ***good-performing models*** *(climate- and hydrological-models)* ***be differentiated from an ensemble of models***?
- EE ***potential method for uncertainty reduction****, in cases where a quantitative validation of the ensemble is not feasible*.
- ***Training material for experts has been developed*** *(7 selected climate models are included for 5 European AquaClew CS, 3 different hydro model structures are included for 3 of these)*
- This presentation focuses on ***introducing the training material and initial results*** *(virtual EE workshop settled for May-June 2020 using TEAMS/Business skype)*
- ***A subset of the EURO-CORDEX EUR-11 ensemble of climate models*** *are used*
- ***Hydrological models*** *skills to simulate the observations at the selected study sites are used*

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Overview of selected CS's and models

Case study		Participating in EE?	
Country	Key issues	Climate	Hydrology
SE	Water quality in lake	Yes	No
DK	Irrigation and drainage requirements	Yes	Yes
FR	Hydropower	Yes	Yes
ES-UCO	Drought and water resources allocation	Yes	Yes
ES-UGR	Fluvial and coastal interactions	Yes	No
		5	3

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Overall idea with EE

We want to end up assigning probabilities to models. We do this by asking experts to respond to two series of general and case specific questions:

- **Block 1 – Warm up.** Appropriateness of the models in general as well as specifically to deal with the case study issues (including considerations on geographic region, simulation variable, etc.). Concludes with ranking of models.

- **Block 2 – Probabilities.** Experts assign probabilities to the individual models of the ensemble for the specific case studies.

Same logic is used for climate and hydrological models, but the specific questions are different. Questions are send to experts before virtual EE workshop. Redone individually after presentations on CS, climate models and hydrological model results.

After individual elicitation of Block 2 probabilities, elicitation repeted in group mode.

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Outline of the training document for experts

1) Case study
2) Location
3) Water-management issue
4) Relevance
5) Case study data
    a. Map of the case study area
    b. Climate
        i. Temperature (Time series and spatial distribution)
        ii. Precipitation (Time series and spatial distribution)
        iii. Other
    c. Hydrology
        i. Rivers (Location and time series of the flow)
        ii. Groundwater (Spatial distribution of the depth to GW)
6) Climate models
    a. Climate model skill on pan-European scale (same for all case studies)
7) Hydrological models
    a. Models used and theory behind the models
    b. Inputs and resolution
    c. Outputs
    d. Differential split sampling test

Material prepared by CSs and partners, follow same level of detail and structure

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Examples of Block 1

To what degree does the GCM-RCM combination capture today's circulation and key teleconnection patterns?

	High	Intermediate	Low
EC-Earth-CCLM	○	○	○
EC-Earth-RACMO	○	○	○
EC-Earth-RCA4	○	○	
HadGEM-RACMO	○	○	
HadGEM-RCA4	○	○	
MPI-ESM-RCA4	○	○	
MPI-ESM-REMO	○	○	

Rank the 7 models (with rank 1 as the most plausible and rank 7 as the least plausible model) *

	1	2	3	4	5	6	7
EC-Earth-C...	☐	☐	☐	☐	☐	☐	☐
EC-Earth-R...	☐	☐	☐	☐	☐	☐	☐
EC-Earth-R...	☐	☐	☐	☐	☐	☐	☐
HadGEM-R...	☐	☐	☐	☐	☐	☐	☐
HadGEM-R...	☐	☐	☐	☐	☐	☐	☐
MPI-ESM-R...	☐	☐	☐	☐	☐	☐	☐
MPI-ESM-R...	☐	☐	☐	☐	☐	☐	☐

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Examples of Block 2

Table 1 Probability chart for eliciting model probabilities. The total probability of all climate models should be equal to 100% and several climate models can have the same probability value.

Climate model	Case study 1	Case study 2	Case study 3	Case study 4	Case study 5	Confidence in general in climate models (1: low - 5: high)
1						
2						
3						
4						
N						
Total probability	100%	100%	100%	100%	100%	
Confidence in ranking (1: low - 5: high)						

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Examples of Block 2

Table 2. Probability chart for eliciting model probabilities. The total probability of all hydrological models should be equal to 100% and several hydrological models can have the same probability value.

Hydrological model	Case study DK	Case study-FR	Case study ES-UCO	Confidence in general in hydrological models (1:low – 5 high)
1	X			
2	X			
3	X			
4		X		
5		X		
6		X		
7			X	
8			X	
9			X	
Total probability	100 %	100 %	100 %	
Confidence in ranking 1: low – 5: high				

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Example from training material

2.2. Hydropower production in France: Southern Alps

Water-management issue:

The hydropower sector is sensitive to climate variables, as these directly affect energy generation and consumption. Climate services provide key information to optimize reservoir operations for hydropower production and to manage water storage to meet the needs of other users (for instance, tourism, agriculture, environmental flows). They also provide guidelines for climate change adaptation and to build strategies that incorporate climate resilience into existing hydropower facilities and the development of new projects. With many climate services flourishing across Europe, the challenge today is to develop energy indicators based on these climate services, which can facilitate decision-making at the regional and local levels.

Study area:

The Durance catchment is predominantly snowy or glacio-nival. The drainage area of the catchment at Espinasses is 3580 km². The basin is located at an elevation of 2020 m on average, with 25% of the surface above 2400 m. The Serre-Ponçon reservoir, located at the southwest of the catchment, is one of the most important in France for hydropower production, with a capacity of 1200 millions of cubic meters.

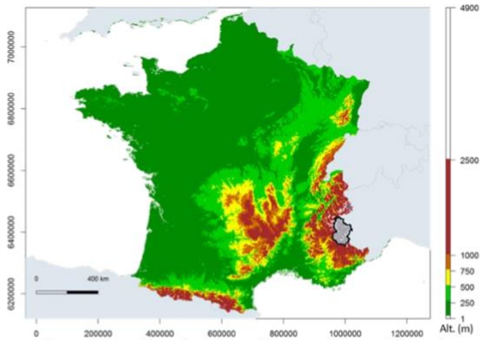


Figure 7. Location of catchment Durance River catchment

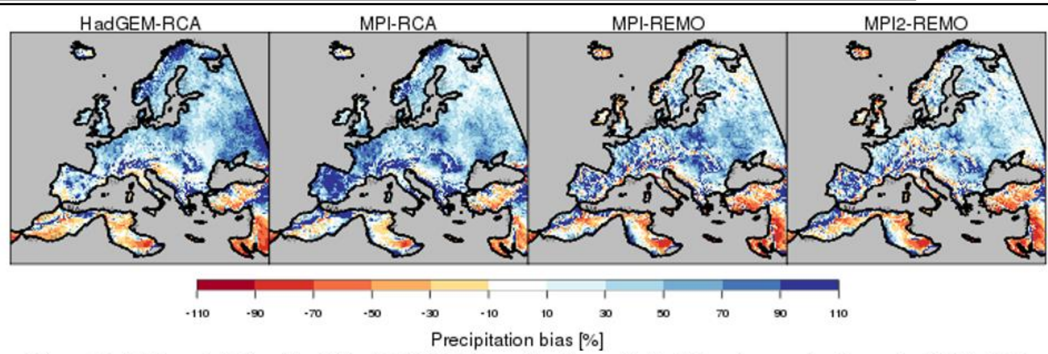
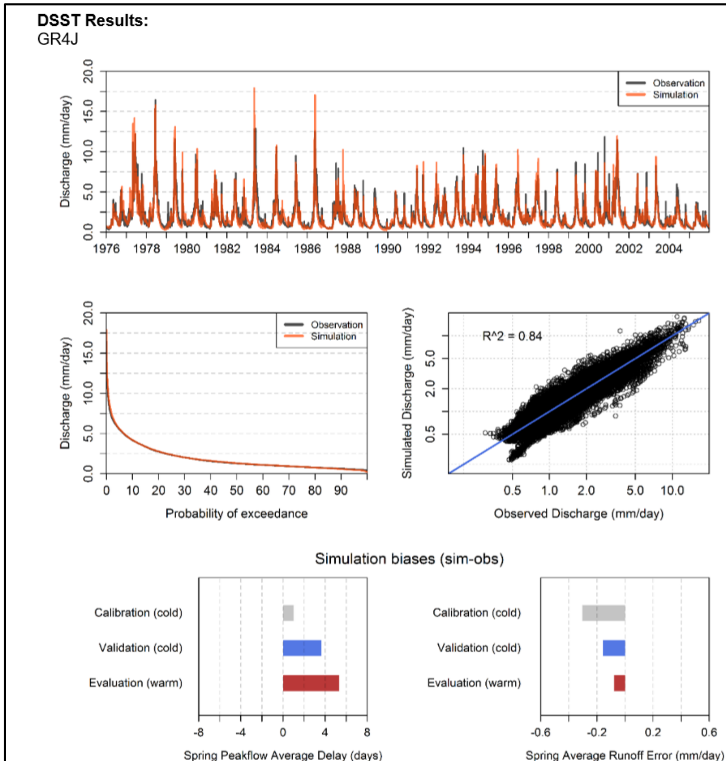


Figure 30. DJF precipitation bias [%] of GCM-RCM combinations with E-OBS reference for the period 1971-2000



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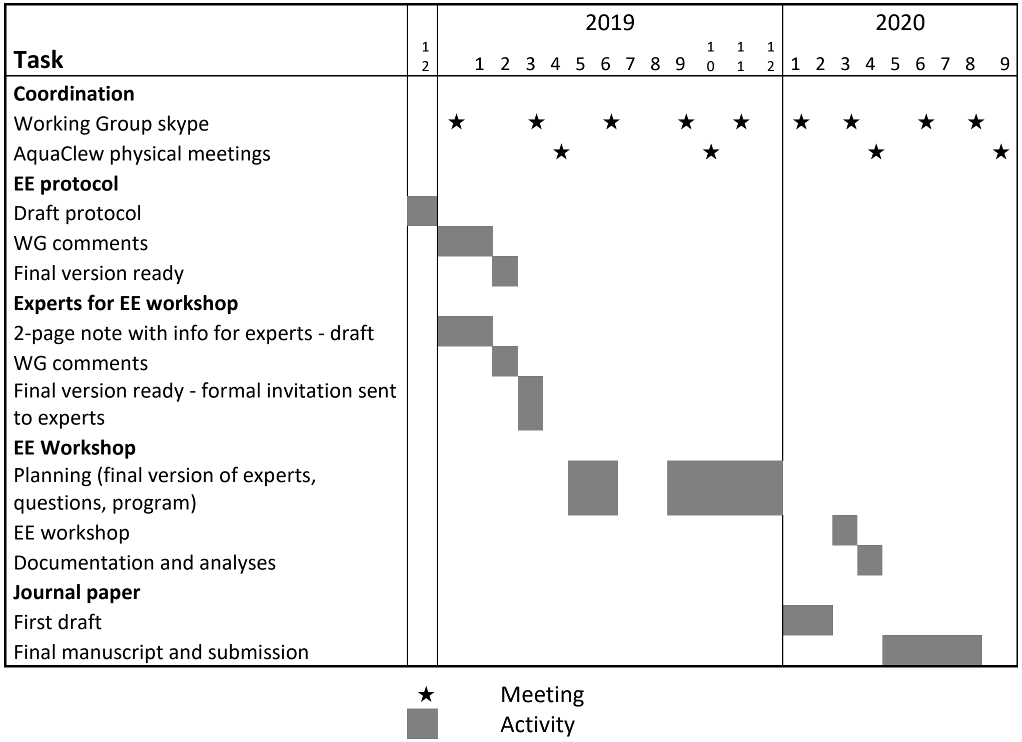
PROCESS

- **Step 1: Define the main issues of elicitation**
- **Step 2: Select experts**
- **Step 3: Plan the elicitation**
- **Step 4: Training of the experts**
- **Step 5: Elicitation**
- **Step 6: Aggregation and analysis of results**



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Week before workshop: Experts receive Questions (Block 1) and send in first individual elicitation

Tentative Program for EE workshop 17 March 2020 in Paris

- 8:30-9:00 Coffee and introduction of experts and participants (who is who)
- 9:00-9:30 Introduction to EE workshop
- 9:30-10:00 Pecha Kucha presentation of each Case Study (CS participants)
- 10:00-10:30 Overview climate models
- 10:30-11:00 Overview hydrological models
- 11:30-12:30 *Expert elicitation*. ***Block 1 questions***. Individual update of evaluation for all questions.
- **12:30-13:30 Lunch break**
- 13:30-14:30 *Expert elicitation.* ***Block 2 probabilities.*** Individual assessment.
- 14:30-14:50 Coffee break
- 14:50-15:00 Presentation of results of EE
- 15:00-16:00 *Group elicitation of* ***Block 2 probabilities*** (both group attempt to find consensus for evaluation of climate models in case studies probabilities)
  - Climate model experts (group 1)
  - Hydrological model experts (group 2)
- 16:00-16:30 Discussion of results

But then COVID-19 arrived!

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Overview of selected experts

Climate modelling experts	Link to AquaClew partner
SMHI/Rosby Centre	External
University of Copenhagen	External
INRAE	Partner organisation
Météo-France	External
BSC	External
University of Genova	External

Hydro modelling experts	Link to AquaClew partner
UCO	Partner organisation
GEUS	Partner organisation
SMHI	Partner organisation
CNRS/Sorbonne Uni	External
GEUS	Partner organisation
BRGM	External

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Initial results: Probabilities

Hydrological model	Case study DK	Case study-FR	Case study ES-UCO	Confidence in general in hydrological models (1:low – 5 high)
1 Two Layer	50%			5
2 Gravity flow	15%			2
3 Richards Equation	35%			4
4 GR4J		35%		3
5 GR6J		34%		3
6 TOPMO		31%		3
7 HYPE			25%	4
8 SWAT			15%	4
9 WiMMed			60%	5
Total probability	100%	100%	100 %	
Confidence in ranking (1: low – 5: high)	5	2	5	

Hydrological model	Case study DK	Case study-FR	Case study ES-UCO	Confidence in general in hydrological models (1:low – 5 high)
1 Two Layer	40			4
2 Gravity flow	30			3
3 Richards Equation	30			3
4 GR4J		50		5
5 GR6J		25		4
6 TOPMO		25		4
7 HYPE			15	2
8 SWAT			40	3
9 WiMMed			45	3
Total probability	100%	100%	100%	
Confidence in ranking (1: low – 5: high)	3	4	4	

Hydrological model	Case study DK	Case study-FR	Case study ES-UCO	Confidence in general in hydrological models (1:low – 5 high)
1 Two Layer	40			4
2 Gravity flow	20			3
3 Richards Equation	40			4
4 GR4J		30		4
5 GR6J		30		4
6 TOPMO		40		4
7 HYPE			0	1
8 SWAT			50	4
9 WiMMed			50	4
Total probability	100%	100%	100 %	
Confidence in ranking (1: low – 5: high)	3	3	2	

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Discussion

- Complexity to perform the online group meeting, involving all experts
- Strong ‘feelings’ ➔ is it possible to reach a consensus?
- Comparison against a quantitative approach, are results similar?
- ‘*There is no replacement for meeting in person’,* since we do the EE in a virtual meeting, will that work for individual and collective probability assessment?
- How can virtual EE workshops be designed and guided, in order to elicite substantive information from experts (individually as well as in groups)?

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